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United States
Department of
Agriculture

Forest
Service

General
Technical
Report
WO-34



Toward Wiser Use of Our Forests and Rangelands

1981 Research Accomplishments



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August 1982

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Foreword

Our Nation's forests are a basic renewable natural resource. Intelligent use of those forests requires another type of natural resource: knowledge. Thus a major function of the Forest Service is to learn how and why things happen in the forest. We not only need to learn how to grow trees faster and use them better, but also how to maintain the resource for future generations. We have a long-term stewardship responsibility.

To solve immediate problems, and to develop the knowledge base to draw on as new problems arise, we conduct research at a network of eight regional experiment stations, plus a centralized forest products laboratory. A map on page 154 shows the location of these facilities, plus their satellite project locations. Much research is done cooperatively with universities, other Federal agencies, and private organizations.

The scope of our research is both fascinating and challenging: from harvesting huge trees to growing tiny seedlings, from protecting grizzly bears to combating tiny insects, from minimizing avalanche hazard in the mountains to increasing streamflow for desert communities. In this report we have summarized about 50 findings that we feel highlight our research accomplishments in fiscal year 1981. They are grouped in the subject areas identified in the Contents on the opposite page.

The findings highlighted here are only a sampling of the new knowledge and technology developed this past year. A complete listing of all our new publications, by subject area, starts on page 50. The categories are not mutually exclusive, so even though you may be primarily interested in one subject, you may find related information in other categories.

If you would like further information about particular accomplishments, please contact the research headquarters mentioned in the highlights or publication citations. Their addresses are on the inside back cover.

A handwritten signature in dark ink, appearing to read "R. Max Peterson". The signature is fluid and cursive, with the first name "R. Max" and last name "Peterson" clearly distinguishable.

R. MAX PETERSON
Chief

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Acknowledgment

R. H. Hamre, Research Information Group Leader at the Rocky Mountain Forest and Range Experiment Station, edited and coordinated the production of this report.

The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.



Products and Engineering

Two Kilns in One Save Energy

It takes energy to turn a log into finished lumber, and much of that energy is used in drying. Two ways to save energy in drying would be to use solar drying or dehumidification drying instead of a conventional kiln. Compared to conventional drying, each of these has its drawbacks—longer drying times, dependence on weather, inability to relieve the stress in lumber as it dries.

Researchers at the North Central Station decided to combine the two energy-saving drying methods in one kiln, hoping to minimize their drawbacks and gain their advantages. The solar collectors provide heat for drying while the sun shines, and the dehumidifier goes into operation at night or when the sky is overcast.

The resulting “solar-dehumidifier kiln” was tested on yellow-poplar lumber. The kiln contained solar collectors made of aluminum beverage cans, a dehumidifier with special refrigerant to allow operation at 180° F., and means to relieve stress in the drying lumber. Drying times for the new kiln were 6 days in summer and 18 days in winter. The dried lumber had few defects, and costs were a third less than for the conventional kiln.

The scientists concluded that the solar-dehumidifier kiln would be an efficient alternative where steam is not available for conventional drying. And it offers even more advantages in parts of the country where sunshine is abundant and electricity relatively cheap.



Operating the solar-dehumidification kiln during winter in southern Illinois. Left to right: solar collectors, kiln, and instrumentation house.

Chitin Inhibition—A New Concept in Wood Protection

Wood preservatives prevent decay and insect attack on wood products because the preservatives are toxic to these invaders. But because preservatives may harm other organisms, the search continues for new and nontoxic ways to protect wood against biological degradation. A new approach is to counter attack by finding a weak spot in the invader's structure.

One key appears to be chitin, an essential building block in the cell walls of most fungi, in the exoskeleton of insects, and in some marine borers that attack wood. It is not found in green plants, man, or other vertebrate animals. Researchers have long known that chitin could be attacked by a substance known as polyoxin. Now investigators at the Forest Products Laboratory have demonstrated that cells of wood decay fungi often swell, rupture, and stop growing when they are exposed to polyoxin. The organism is not poisoned in the conventional sense, but is prevented from growing normally. Thus, wood decay is greatly retarded or prevented. Most important, however, is the safety of this new narrow-spectrum toxicity concept. The approach is potentially less hazardous than present preservative treatments with chemicals that are toxic to a wide range of organisms, in addition to wood-destroying fungi and insects.

Possibilities for application are great since only about 12 percent of solid wood products are now treated with preservatives in this country, and losses due to insect and decay are still large. Stopping decay and insect attack could mean that enormous quantities of wood products would not have to be replaced—effectively stretching our timber resource.



FPL scientist Bruce Johnson (center) discusses chitin inhibition with staff members George Chen and Becky Schumann.

Paper Mill Wastes Can Help Solve Pollution Problem

Waste products from pulp and paper production may hold the key to solving a chronic pollution problem for the pulp and paper industry. Scientists at the Forest Products Laboratory have found that the primary sludge from a papermill's waste treatment plant can be used to remove the dark color from kraft bleach plant effluent. Industry is under increasing pressure to remove the dark brown waste products in the bleach plant effluent. The brown wastes come from lignin, a major structural component of wood.

Scientists have found that when the sludge from the primary clarifier is mixed with the colored effluent, it removes up to 90 percent of the color. The darkened sludge can then be removed and disposed of in a landfill or other currently approved manner. The process is very rapid.

Most mills produce more than enough sludge for complete color removal. Although the primary sludge contains a considerable amount of waste cellulose, it is the metal ions in the sludge that precipitate the color.

This research was done in collaboration with North Carolina State University and several pulp and paper companies.

This new method of color removal, called DAS (*Decolorization with Acidified Sludge*), is currently being evaluated by engineers for practical and economic feasibility. One company is planning a pilot-scale evaluation.

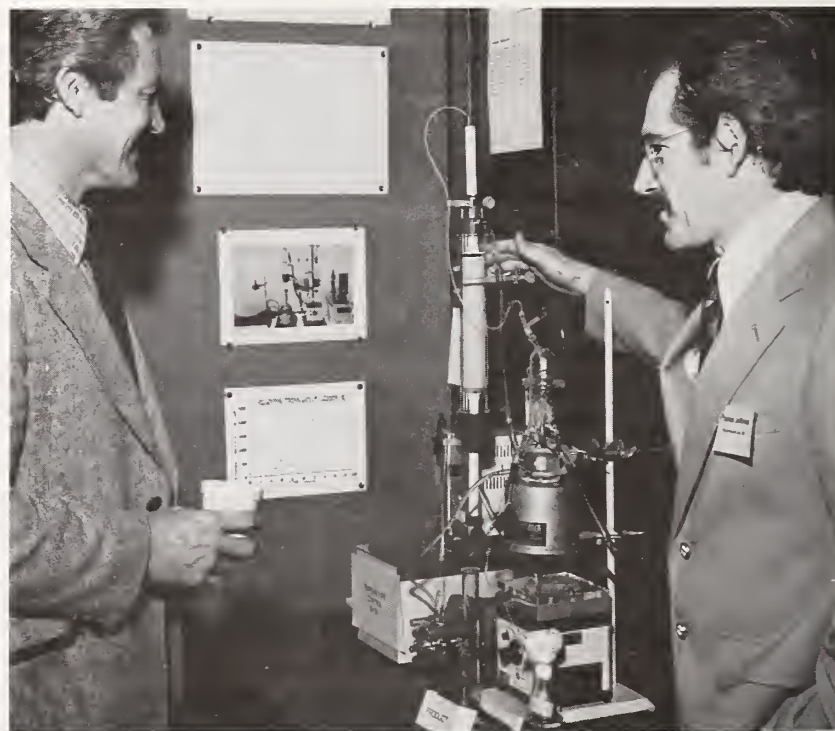


FPL microbiologist Suki Choi compares clear, sludge-treated effluent with typical untreated mill waste discharge.

Alcohol from Xylose in Hardwoods

Pulp and paper companies that process hardwoods could soon produce ethanol from their waste streams. New findings show that certain yeasts can convert the sugar xylose to ethanol and various other products. Hardwoods yield far more xylose than do softwoods. If rates and yields can be improved, the production of ethanol from hardwoods might be doubled by utilizing xylose as well as glucose formed by acid hydrolysis.

Researchers at the Forest Products Laboratory discovered that, under aerobic conditions, the yeast *Candida tropicalis* can convert xylose into ethanol. Reports of almost simultaneous discoveries made with other yeasts at other laboratories have stimulated interest of industries and laboratories in xylose fermentation. It now appears that the fermentation of xylose to ethanol might be commercially possible in 3 to 5 years.



FPL microbiologist Tom Jeffries explains xylose-alcohol fermentation process during a Forest Products Research Utilization Conference in Madison.

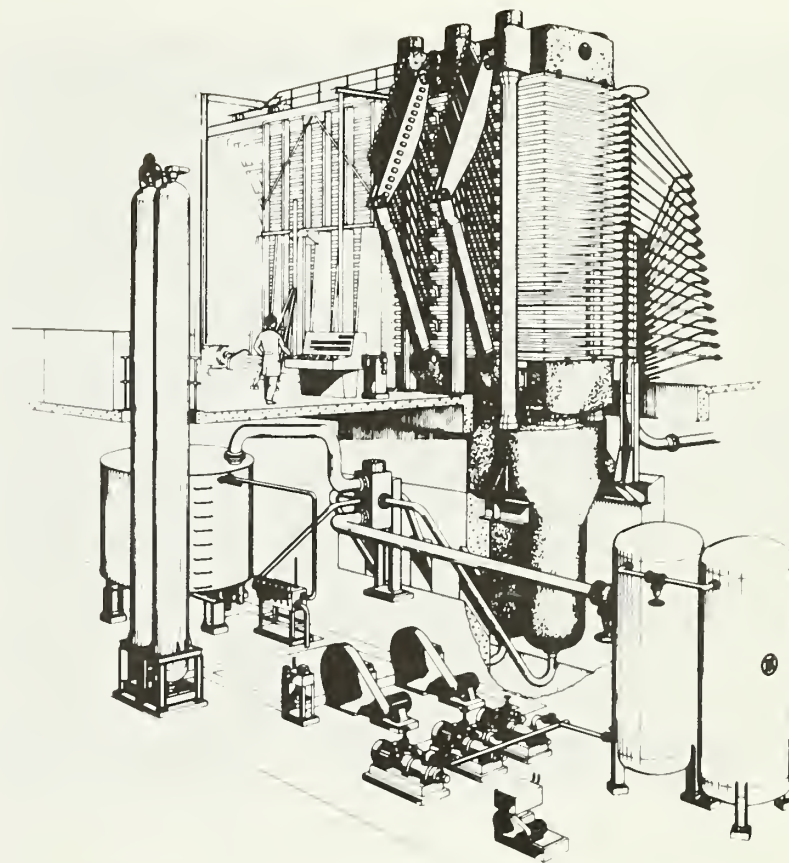
Making Big Ones Out of Little Ones

As our original old forests are replaced by second-generation managed forests, large, high-quality logs for panel products are becoming increasingly scarce and expensive. As a result, forest products researchers are developing and improving alternative ways of making reconstituted wood panel products from small trees and wood residues.

Research at the Southern Station resulted in technology for using large volumes of abundant low-grade southern hardwood trees for flakeboard. A \$25 million plant based on this technology is under construction in Louisiana. Other Forest Service research improved a product called COM-PLY, a hybrid panel made of flakeboard sandwiched between plywood veneers. Four plants can now produce a COM-PLY type of product, and many more are expected to be built.

In related, process-oriented research, scientists at the Forest Products Laboratory developed a way to drastically reduce pressing time during particleboard production. They modified a conventional press so they could inject steam into the curing particleboard. The steam quickly heats the center of the mat of wood chips and adhesive, cutting curing time by 1/2 to 3/4. The steam injection press will permit thicker particleboards to be produced and allow study of thick-particle molding. This development will also allow presses to operate at lower pressures, and may make a continuous press feasible.

These developments will not only help hold down costs of reconstituted wood panel products, but will also shift harvesting pressure to more abundant, lower value trees and residues.



A \$25 million multi-opening hot press for producing flakeboard is being installed in Louisiana.

Salvaging Timber in the Mount St. Helens Blast Area

The violent eruption of Mount St. Helens on May 18, 1980, devastated about 234 square miles of timberland in the State of Washington. On the Gifford Pinchot National Forest alone, an estimated 1.6 billion board feet of timber was affected by the blast. The condition of the trees damaged by the blast varied from blown away and completely destroyed to scorched but still standing. Most commonly, the blast area was left with a mixture of down and standing broken trees. Unless successfully salvaged, millions of board feet of lumber from killed trees might be lost to the U.S. economy. However, the actual extent of damage to these trees was unknown and their potential value was in question.

Scientists at the Pacific Northwest Station moved quickly to determine the salvage potential for standing dead and blown-down timber in this area. Of prime concern was the volume of timber lost due to breakage. Surprisingly, in areas where timber remained, the percent of breakage was generally no greater than that which normally occurs during tree felling operations in the Pacific Northwest. This research information has enabled more rapid planning for salvage sales on the National Forest, speeding recovery operations of timber that might otherwise be lost to decay, insects, or fire.



Timber blown down or killed by the eruption of Mount St. Helens had breakage typical of that found in normal felling operations.

Steep Slope Harvester

Mechanized small-tree cutting equipment has not been available to operate on slopes over 30 percent. Because it is not economical to harvest individual small trees on steep terrain, a system was needed to cut and bunch small trees. A cooperative effort between the Forest Service and industry resulted in a unique harvesting concept for steep slopes.

Forest Service researchers designed and fabricated a cutting and bunching head for mounting on a unique excavator capable of operating on slopes between 35 and 85 percent. It also has good potential for thinning, planting, and swamp harvesting. Initial research and reports by the Forest Service have spurred industry interest. It is expected that the concept will permit harvesting of vast quantities of small timber on steep slopes. Probably over 20 million acres of forest land could be harvested economically with this new equipment.



Sloping land with small trees can now be harvested economically with this equipment.

Alternative Designs Reduce Impacts of Forest Roads

Most forest land management activities require the construction of roads. Forest roads are a major contributor to soil and hydrologic disturbances on the site, as well as downstream water quality degradation. Research to determine the effectiveness of alternative design and construction practices indicate (1) significant increases in sediment during and following road construction; (2) stabilization treatments effectively reduce sediment movement into streams; (3) untreated fill slope erosion decreases rapidly over time, whereas untreated cut slope erosion does not; and (4) cut slope erosion is greatest during spring snowmelt, while fill slope erosion is greatest during summer storms.

The Intermountain Station, in cooperation with the Northern and Intermountain Regions, is developing cost-effective means of reducing or avoiding construction impacts. On two sites in steep, sensitive terrain, roads are being constructed to varying standards, and with varying postconstruction treatments. Erosion and downstream water quality are being carefully monitored.

Results of the research will help managers specify forest road design and construction practices, and predict impacts of road construction. Cost-effectiveness can be assessed in terms of probable reduction in adverse impacts achievable with a specific dollar investment.



Alternative designs provide cost-effective ways to reduce impacts of forest roads.



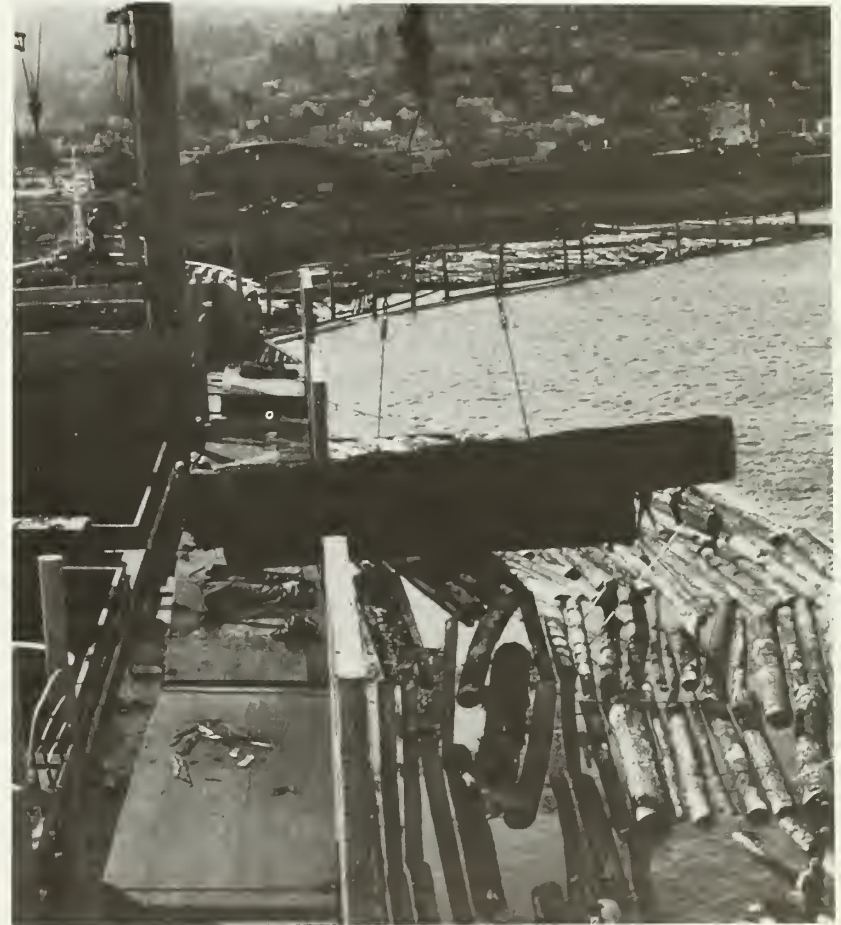
Resource Economics

How Do Log Exports Affect Domestic Prices?

The value of softwood log exports from the West Coast exceeds \$1.4 billion per year. Most of these logs go to Japan, where they are processed into lumber for use in Japan's housing industry. Timber owners, processors, and consumers have a stake in U.S. policy on softwood log exports. What would happen to timber, lumber, and plywood prices if log exports were banned? How much volume does Japan need?

The response of producers and consumers to a ban cannot be accurately predicted, but researchers at the Pacific Northwest Forest and Range Experiment Station have been able to show what might happen. The main effect would be to lower timber prices in the Pacific Northwest. This would benefit log processors at the expense of timber owners. Plywood prices would decrease by less than 4 percent. Lumber prices would go down by less than 2 percent, and might increase if processing capacity did not expand on the West Coast.

Japanese markets for imported logs are expected to remain strong through the 1980's, but probably will not grow. Over the past 15 years, growth in imports was caused in part by rising demands for housing resulting from the Japanese version of "baby boom" and demand for better quality housing.



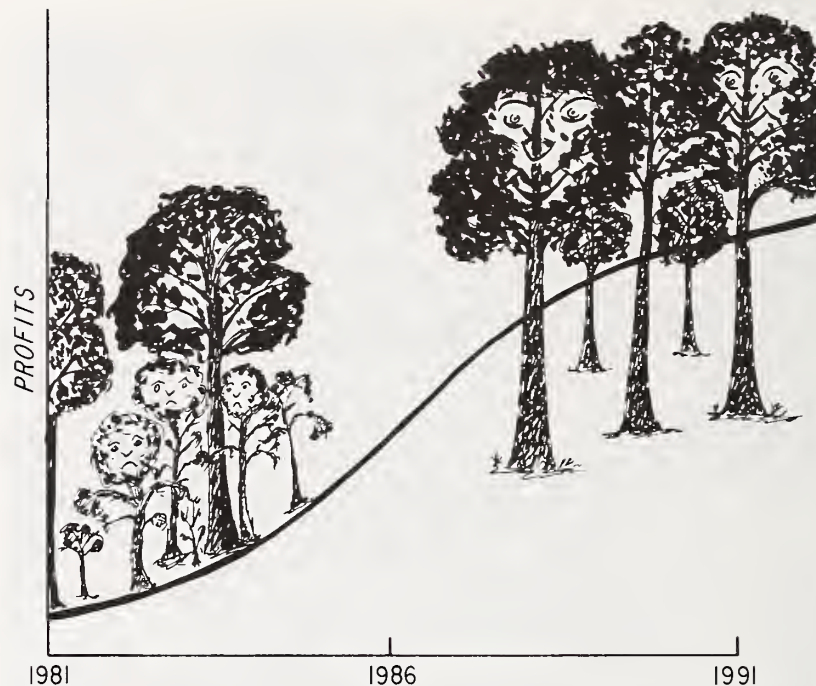
Banning of log exports would have many implications, including lowering of timber prices in the Pacific Northwest.

TSI—When and Where?

“Timber stand improvement”—TSI for short—is the phrase foresters use to describe treatments designed to eliminate undesirable and unsalable trees to make room for desirable ones. These treatments require an investment by landowners, and foresters often have difficulty getting small landowners to make these investments. One reason is that foresters prefer to think in board feet and cords, while investors prefer to think in dollars and rates of return on investment.

A research economist at the Southeastern Station has designed a simplified system for estimating economic rates of return from TSI investments. To estimate returns, a forester must know the cost of treatment, the time between treatment and harvest of the improved stand, the improvement in quality resulting from treatment, and the difference in price between the low-value products of the unimproved stand and the high-value products of the improved stand. Other factors considered are the owner's tax rate, and the rate of return the owner would like to obtain. With this information, the forester uses a series of tables in cookbook fashion to determine whether a particular TSI opportunity will be economically attractive to a particular landowner.

In many instances, investments in TSI are economically the most attractive in forestry. Whereas tree planting seldom yields a profit in less than 30 years, TSI often produces a return in 10 years in the South. Where the percentage of high-value products can be meaningfully increased in that amount of time, returns on investment are surprisingly high.



Small investments in stand improvements can increase timber value and financial returns.

Are Investments in Hybrid Poplar Plantations Profitable in the Lake States?

Is intensive culture of fast-growing tree species for biomass production, either for fiber products or energy, economically feasible? Forest economists in the Lake States have completed a detailed analysis of financial returns under varied assumptions of intensive cultural methods, yields, and product values.

Their conclusions are that hybrid poplar plantations could be an attractive investment for an industrial user of wood, particularly if a secure source of wood is important. However, under current product price assumptions, such an investment probably would be much less attractive to an individual landowner because markets and incomes would be uncertain. Another important finding of the study is that irrigation does not increase product yields enough to offset the associated higher costs.

The methods developed in the study will provide a convenient analytical framework for periodic reevaluation of intensive culture opportunities as better yield information becomes available, or as costs or product prices change significantly.



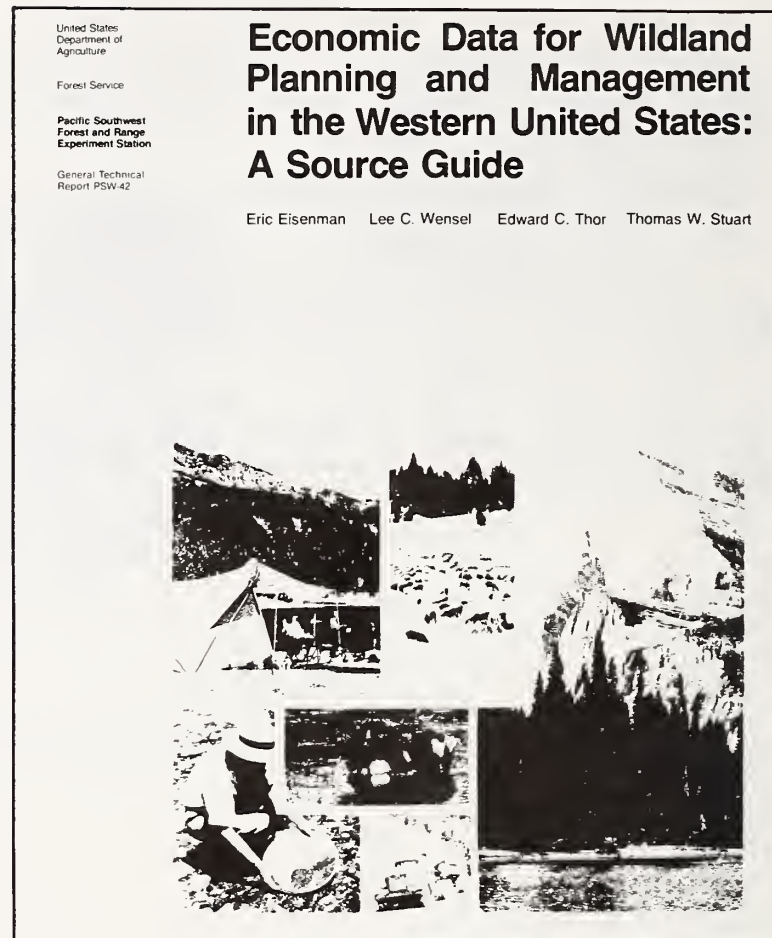
Six-year-old hybrid poplars in a Lake States plantation.

Wildland Economic Data: Where and How To Find It

The economic data needed for wildland planning and management may already be available from another organization. But knowing where to look or who to ask has always been a problem.

A report compiled by the Pacific Southwest Forest and Range Experiment Station, in cooperation with the University of California at Berkeley, lists sources of economic facts and figures useful in planning and managing forests and rangelands in the Western United States. In addition to providing a section on general economic and social data, the report provides sources classified by six major management activities: outdoor recreation and wilderness, wildlife and fish, range, timber, land and water, and minerals and energy. Within each section, data sources are identified as providing costs of management activities, outputs and their monetary values, nonmonetary data and impacts, information for supply and demand analysis, and secondary and indirect effects.

The report is available as General Technical Report PSW-42, "Economic Data for Wildland Planning and Management in the Western United States: A Source Guide."



This report from the Pacific Southwest Station gives sources for economic data on recreation, wilderness, wildlife, range, timber, water, and minerals.

Measuring the Economic Pulse of Timber-Dependent Communities

Commercial bank performance may indicate how Oregon communities adjust to the expected decline in timber production, according to a study by the Pacific Northwest Forest and Range Experiment Station. This study may help identify areas where public policies could play a vital role in determining the economic fate of timber-dependent communities.

Traditionally, commercial banks in Oregon have been net importers of investment funds. But recent findings indicate that several counties in southwest Oregon have been exporting an increasing share of deposits—in some cases for as long as 15 years. Because funds tend to flow from slower to faster growing areas, the southwest Oregon communities may be less resilient to economic change than communities elsewhere in the State. Consequently, achieving community stability may dictate a different allowable cut policy for southwest Oregon than for the remainder of the State.



Bank loans and deposits may indicate how timber-dependent communities adjust to changes in local timber harvest levels.

Particleboard and Plywood Potentials in the Black Hills

The forest products industry in the Black Hills is characterized by a large surplus of residues at existing mills, supplemented by supplies of small roundwood, and drastic fluctuations in demand for lumber products. In an effort to help improve these situations, forest products technologists and economists at the Rocky Mountain Station conducted major studies on the potentials for producing particleboard and plywood from Black Hills ponderosa pine, a species especially preferred for particleboard.

A particleboard plant providing an economical outlet for wood residues and small roundwood, in addition to generating needed jobs and income in the area, would ultimately widen the options available for forest management. The analysis indicated that a plant of 100 million square feet annual capacity should offer the best opportunity in the cyclic particleboard market.

The plywood study, conducted concurrently, responded to interest within the Black Hills forestry community in expanding and diversifying production of timber products. The drastic swings in housing markets, which affect demand for the area's lumber products, could be tempered to some degree by greater product diversity.

The most promising markets for both ponderosa pine particleboard and plywood for Black Hills producers are in the Midwest and Lake States. Particleboard would be sold as panels or remanufactured into a variety of secondary products. Plywood from ponderosa pine would be of a type suitable for sheathing, siding, underlayment, or as stock for remanufacture.



Ponderosa pine plywood from the Black Hills would have promising markets in the Midwest and Lake States.

California Has High Timber Growing Potential

California ranks second in the United States in total forest area (40 million acres). Although over half of the forest land is considered to be unproductive for growing industrial wood, the 16.3 million productive acres include some of the most productive forest land in the world. Twenty six percent of the area is capable of growing 120 or more cubic feet of wood per acre per year. Current yields are less than half of the land's potential, however, and at least 5 million acres are inadequately stocked, or occupied by commercially undesirable trees. If the 1.2 million most productive of these 5 million acres were stocked with conifers now, in 70 years annual yield could be increased 700 million board feet—equivalent to almost a fourth of the State's total 1980 timber harvest.

The intensity of forest management has increased dramatically in recent years. For example, timber companies planted and seeded only about 7,000 acres per year in the 1960's. The total increased to 24,000 acres in 1976 and 37,000 acres in 1977. These investments will begin to yield timber products some time after the year 2000.

California forest industries employ from 85,000 to 90,000 persons, most of them processing California-grown timber. Although timber industries contribute modestly to the State's economy, they are extremely important to many communities in the northern part of the State, and the Sierra Nevada.



Mixed conifer forest on California's Stanislaus National Forest.

Multi-Resource Inventories Identify Valuable New Relationships

The added information being collected during multi-resource inventories in the Southeast has helped to identify new resource relationships. Information obtained as part of the resource inventory in South Carolina revealed the occurrence and severity of damage to the timber. Procedures were also developed for evaluating the suitability of forest lands as breeding habitat for nine nongame bird species over a broad range of habitat types. These studies are laying the groundwork for more detailed analyses of a variety of forest resource values.

In South Carolina, hardwood trees had more damage than softwoods. Black cherry, black walnut, black locust, and red oak seemed to be most susceptible among hardwoods. Fusiform rust was the most common damaging agent found on softwood trees. Fire damage was found on all species and size classes, but the percentage of trees affected was low.

Computer-generated bird habitat maps were made for South Carolina after an intensive evaluation of the habitat requirements for nine selected species. Distribution and quality of suitable forest habitats were different for most of the birds. Those with most restrictive requirements had the smallest acreage of suitable habitat.



In South Carolina, hardwood sawtimber trees are frequently damaged by cankers.

Resources Evaluation Assists Industrial Development

Forest resource planning requires information about forest condition, past trends, and potential. Resources Evaluation research gathers and analyzes information about the Northeast's forest resources to assist planners, managers, and other decisionmakers in the public and private sectors.

A few examples show how this information is used. A European furniture manufacturer was investigating locations for a timber processing plant in the oak-rich region of the Middle Atlantic States. New forest resource statistics, from an inventory of Pennsylvania's forest lands by the Northeastern Station's Resources Evaluation unit, revealed the advantages of several Pennsylvania sites. When a State forestry specialist and officials from the Commerce Department went to Belgium with this new information, Lock Haven was selected for the new plant site.

Data summaries for Ohio's forest resource were used by a large paper manufacturer to modify future productivity plans at its Ohio installation. Another paper company used detailed Pennsylvania forest resource data and specific analytical interpretations for the company's woodshed to develop more effective planning and production control.



Information about the Northeast's forest resources is available to help public and private land managers.

Plot Remeasurement by Computer

It currently costs between \$275 and \$300 for Resource Evaluation field crews to install or remeasure an inventory plot in the North Central Region. Researchers are testing a new technique to save money and shorten the time between statewide inventories. Scientists have developed a computer model of tree growth called STEMS. This model will be used to derive an estimate of change at each sample plot, given plot data from a previous survey. Problems arise, though, if disturbances such as fire, cutting, or planting have occurred since the last measurement. Disturbances can usually be detected by comparing old and new aerial photos of the plot location.

In one northern Wisconsin county, new 1:20,000 aerial photos of sample plots are being compared to old photos of the same plot taken for the last inventory. Plots that show disturbance are remeasured by field crews. Timber volume and growth on undisturbed plots will be estimated by STEMS. A portion of the undisturbed plots will be remeasured by field crews to check STEM's accuracy. If STEMS does well, it will be possible to greatly reduce the number of undisturbed plots revisited, thus saving both time and money.



Labor-intensive field work can be reduced by using computer program STEMS to predict growth.



Insects and Disease

Predicting Douglas-Fir Tussock Moth Outbreaks

An early warning system triggered by response to a synthetic sex attractant now alerts forest managers to impending outbreaks of the Douglas-fir tussock moth, one of the most destructive defoliators of Douglas-fir and true firs in western North America. Because moth populations can increase rapidly, early prediction of potential outbreaks is imperative so managers can implement prompt actions to reduce losses.

The warning system, developed by Forest Service scientists and cooperators, has been implemented at more than 800 locations throughout California, Oregon, Washington, Idaho, and British Columbia by Federal, State, and private pest management specialists. The system uses "sticky traps" baited with a synthetic sex attractant to capture male moths. The number of moths captured provides a measure of population trend. By using this system to monitor tussock moth populations, forest managers learn of impending outbreaks sooner, and can better evaluate alternatives for managing the problem.

Trapping results from 1980 warned of small 1981 outbreaks in Idaho and British Columbia. Trapping in 1981 has focused attention on additional areas in Oregon, Washington, and British Columbia where outbreaks might develop in 1982 or 1983. Pest management specialists will follow these early leads with more intensive surveillance to determine needed management actions.



A monitoring system for the Douglas-fir tussock moth uses traps baited with a sex attractant.

The Southern Pine Beetle: A Synthesis of What We Know

A summary of present knowledge about the southern pine beetle has been published in a 12-chapter compendium that emphasizes findings from the Expanded Southern Pine Beetle Research and Applications Program. The southern pine beetle is the most destructive insect pest of pines in the Southern and Southeastern United States. It disrupts long-range management planning, reduces potential yields of goods and services, destroys the timber capital of small landowners, and reduces other forest-related values. The compendium provides a complete synthesis of knowledge of the insect, describes the beetle problem in southern forests and how to manage it, and outlines research and development needs for the future.



Technical Bulletin 1631 summarizes what we know about the southern pine beetle.

Seed Orchards Produce Rust-Resistant Southern Pine Seeds

Fusiform rust is by far the most damaging tree disease in the Southern United States. It kills and deforms loblolly and slash pines, the most commonly planted species in the region, and damage is more severe in plantations than in natural stands. The value of trees lost to the disease is estimated to be well over \$75 million per year.

The literal fruits of a long-term research effort by the USDA Forest Service and its cooperators are commercial quantities of rust-resistant seeds available from recently established orchards. Plant pathologists discovered that slash and loblolly pines vary considerably in their resistance to fusiform rust, and that some trees passed this resistance on to their progeny. Seeds from resistant individuals with other desirable characteristics were used to start seed orchards. One of the largest is a 60-acre orchard established by the Georgia Forestry Commission with the technical help of Southeastern Station geneticists and pathologists. This orchard yielded enough seeds in 1981 to produce a half million rust-resistant seedlings. Full production, expected by 1985, should yield enough seeds to produce 15 to 20 million seedlings annually.

Use of resistant seedlings in areas of high rust hazard should reduce losses about 50 percent in slash pine and 40 percent in loblolly pine. These reductions will translate into millions of dollars in increased profits for growers of southern pines.



Southern pines with inherent resistance (background) are less damaged by fusiform rust than ordinary trees (foreground).

Predicting Gypsy Moth Damage

Combating the devastating effects of the gypsy moth is one of the greatest challenges facing forest managers in the Northeast today. During 1981, this pest defoliated over 12 million acres of forest land—more than twice the acreage recorded in any previous year. To help remedy this situation, researchers at the Northeastern Forest Experiment Station have developed models to estimate the potential hazard of impending gypsy moth outbreaks.

Using field data collected during a 1970's outbreak in northeastern Pennsylvania, scientists developed mathematical models for predicting stand losses and for guiding control efforts. These models are now being tested and refined. The models make use of easy-to-measure stand condition characteristics such as tree vigor, species, and tree size. With the assistance of these models, managers will be better able to evaluate the cost effectiveness of various control alternatives for management of gypsy moth outbreaks.



A hardwood forest stand devastated by the gypsy moth.

New Methods for Evaluating Experimental Insecticides

Each year at laboratories throughout the world, hundreds of insecticides are rated for their potential effectiveness in killing major forest pests. These laboratory tests typically determine what doses of various formulations are lethal to a specific percentage of the target pest population. The job of analyzing the immense amounts of data gathered is painstaking, time consuming, and expensive.

Scientists at the Pacific Southwest Station have developed new computer programs that can quickly analyze data about response of the spruce budworm, the Douglas-fir tussock moth, and other major insect pests to various doses of insecticides.

The programs (POLO-1 and POLO-2) are statistically sound, easy to use, and more informative than any other computer programs currently available for these types of analyses.

The programs are currently operational on the Univac 110 series, but they can be modified for other computers. Both programs and publication guides to assist users are available from the Pacific Southwest Station.



One way to test effectiveness of insecticides is to allow larvae to feed on treated food pellets.

Chlorpyrifos—A New Insecticide for Termite Control

Forest Service scientists at the Southern Forest Experiment Station have demonstrated that chlorpyrifos, the active ingredient in Dursban, provides excellent protection against subterranean termites.

Protection from subterranean termites is a necessity for structures and products made of wood in many parts of the world. In the United States, aldrin, chlordane, dieldrin, and heptachlor have been the only insecticides approved for long-term control. Because of their human health and environmental hazards, however, use of these chlorinated hydrocarbons has been so restricted that their manufacture may no longer be warranted.

Field trials of alternative insecticides begun in 1967 showed one chemical, chlorpyrifos, to be effective against subterranean termites for 14 years. Chlorpyrifos, now registered with the Environmental Protection Agency, is the first new insecticide for soil treatment against subterranean termites in the United States in about two decades.



Heavy subterranean termite damage to structural members in a home.

Stand Risk Rating for Southern Pine Beetle

A stand risk-rating system, developed by the Southern Forest Experiment Station, is now in use to identify stands susceptible to the southern pine beetle. The system uses readily available data from routine forest inventories. Southern pine beetle management can be integrated with forest management by this risk-rating approach, since it enables the forest manager to more easily judge potential southern pine beetle problem situations. It helps the manager decide which stands to thin or regenerate, and which stands to monitor for potential beetle problems. When outbreaks occur, beetle control efforts can be focused on high-risk stands.

The system was developed through a comprehensive research effort to identify site, stand, and host conditions that are associated with southern pine beetle infestations. Experience in the past 5 years on more than 100,000 acres of the Kisatchie National Forest has demonstrated that the stand risk-rating system accurately predicts beetle infestations. Major field trials showed infestation frequency in high-risk stands to be twice that in medium-risk, and four times that in low-risk stands. This technology is currently being extended from the Kisatchie National Forest to other southern forests as a first step in integrating southern pine beetle management with forest management.



Southern pine beetle infestation in an over-stocked, high-risk loblolly pine stand.

Cone and Seed Insects of North American Conifers

Insects that attack cones are one of the major obstacles to achieving maximum cone and seed production in southern seed orchards. These orchards are essential for the production of genetically improved seedlings for regeneration of southern pine forests. Information on biology and identification of cone and seed insects is an important ingredient in formulating effective and practical pest management systems.

The recent publication of "Cone and Seed Insects of North American Conifers" provides foresters, seed orchard managers, entomologists, and others, with the first practical and easy-to-use guide on the identity, biology, damage, and importance of the significant cone and seed insects of North American conifers. It is richly illustrated and presented in a format that facilitates easy reference, even by the nonspecialist. Forest Service scientists cooperated with entomologists in Canada and Mexico in the preparation of this useful working tool.



A larva of the shortleaf pine cone borer feeds inside a shortleaf pine cone.



Environment

Rehabilitating Gullies

Many wildland areas in the Western United States have been severely gullied, usually the result of land mismanagement—overgrazing, improper vegetation conversion, poor regeneration after logging—or by uncontrollable changes in climate. Sediment rates from severely gullied watersheds can amount to 100 tons per square mile per *day*, compared to perhaps that much per *year* from most wildland watersheds in the United States. Gullies not only reduce productivity of the eroded site, but choke downstream channels, lakes, and reservoirs with sediment.

Gully networks can be successfully rehabilitated with check dams or vegetation, or combinations of both. Research at the Rocky Mountain Forest and Range Experiment Station shows that, in the arid and semiarid West, the best treatment is small dams constructed at critical locations, supplemented with extensive revegetation and good land management. This combination gives the highest return with the least investment.

Successful gully treatment requires knowledge of channel dynamics, engineering structures, and vegetation management. The important aspects of these widely different disciplines have been brought together for the land manager in a series of video-tape training films available from Colorado State University and the University of Arizona. These films present both the theoretical and practical aspects of gully development and control, evaluating critical locations, spacing of check dams, and prioritizing treatments in gully networks.



New vegetation nearly hides the series of rock check dams that have stabilized this gully.

Forest Nutrients, Acid Rain, and Time

Nearly two decades of close observations at the Hubbard Brook Experimental Forest in New Hampshire's White Mountains provide an unequalled record of nutrient status in forest soil and streams. And, since 1963, scientists there have developed the longest continuing record of precipitation chemistry anywhere in the United States. They use air parcel analyses to determine the origin and path of airborne pollutants that cause acid precipitation. Storms from the West and Southwest bring rain and snow that is more acidic than storms from other directions.

Forest Service scientists and their cooperators also collect long-term information on how timber harvest changes the nutrient status of forest soil and streams. Together, these observations provide an invaluable basis for knowing how the nutrient status responds to the combined influences of tree cutting and atmospheric impurities. For example, acid rain is greatly modified as it passes through the canopy of northern hardwoods; passing across bark and leaves reduces its acidity 10-fold even while increasing its nutrient content. Whole-tree harvesting temporarily eliminates this buffering action of the canopy, exposing soil and streams to direct inputs of acid rain. A long period of observation is prerequisite to management action for dealing with the effects of acid rain on forest soil and streams. Information accumulating at Hubbard Brook provides a much needed perspective to devise effective action.



When only the tree trunk is harvested (top), branches and tops remain on the site. With whole-tree harvest (bottom), more biomass and associated nutrients are removed.

Protecting Buildings from Avalanches

The number of people living and working in steep, snow-covered mountainous areas has increased sharply in recent years, and their numbers are expected to continue increasing. The buildings they live and work in should be located in places safe from avalanches, a precaution not always feasible. When buildings and other structures must be placed in or near avalanche runout zones, measures must be taken to protect them, as well as the people who use them. Guidelines have been developed for locating earthen mounds, dams, and deflecting walls in the lower part of the avalanche path, and for modifying buildings to protect them from avalanches.

Protective structures vary with the type of avalanche expected, terrain features, and the degree of protection required. Some structures deflect the moving snow away from buildings; some slow the avalanche to a stop before it reaches the building; others trap the moving snow. Another approach involves strengthening buildings to withstand the avalanche impact. A new publication, "Design Criteria for Avalanche Control Structures in the Runout Zone," General Technical Report RM-84, is available from the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.



This restaurant at Vail, Colorado, lies within an avalanche runout zone. The windows are artificial — the wall actually consists of reinforced concrete.

Managing Ecological Impacts at Wilderness Campsites

One of the most vexing problems in managing wilderness and back country areas is deciding what to do about degradation of natural conditions in areas of concentrated recreational use. Ground cover is lost and tree roots are exposed on most popular campsites. The common practices managers use to alleviate these problems are to divert recreationists to areas of lesser use, or temporarily or permanently close the disturbed campsites.

Researchers at the Intermountain Forest and Range Experiment Station have found that such actions will do little to improve the condition of campsites, and that a larger area will usually become deteriorated. Campsite degradation due to recreation use is unfortunate but inevitable. Therefore, managers should attempt to confine recreation use to as small an area as possible. In most places, this can be done by encouraging users to concentrate, as they usually do, on permanent campsites. These sites should be dispersed locally to increase solitude and should be located in areas most capable of absorbing use. Damage to the sites can then be minimized by regulating the type of use and, if necessary, sites can be hardened, thereby limiting the inevitable damage and leaving most of the wilderness undisturbed.



Researcher measures changes in ground cover conditions at a wilderness campsite.

Tree Managers: They Even Use the Shadow

Winter and summer shade can affect your energy bill. Summer shade is valuable because the shadow reduces cooling needs. Shade from the same tree in the winter is unwelcome; a shaded building or home requires more energy for heating.

Winter shadows are larger than summer shadows because the sun is low in the sky. Although the shaded area is greater, the resulting energy effects were thought to be small in hardwood stands because the trees were bare. Recent research at the Northeastern Forest Experiment Station has shown, however, that leafless trees intercept a greater portion of solar energy than suspected. From one-third to one-half of the energy is intercepted by the branches. Techniques and programs are now available that accurately predict shadow location for both forests and individual trees within a stand. When shadow locations are known, stands can be managed as useful shade sources.

Forest management techniques are now being developed for obtaining both summer and winter benefits through use of this knowledge of shade patterns. These techniques could benefit everyone by lowering home heating and cooling costs, and reducing the Nation's energy needs.



Models are used to simulate the patterns and effects of tree shade.

Cattle Grazing and Fish Habitat—Reducing the Conflicts

Can riparian areas that border western streams be grazed by livestock and maintain high-quality water and fishery habitat? In the interior Pacific Northwest, this question is particularly important because small headwater streams that traverse rangeland contain the critical spawning habitat for anadromous steelhead trout and salmon.

To protect a stream, it is necessary to maintain shade along its banks, prevent breakdown of the bank, and reduce stream sediment. But fencing cattle away from all critical stream reaches would significantly affect the economics of cattle ranching in the West. Scientists of the Intermountain and Pacific Northwest Forest and Range Experiment Stations are therefore evaluating various grazing systems to identify those that are compatible with quality water and a productive fishery. A key finding is that the stability of the streambank and riparian vegetation provides an “early warning” of grazing use that will degrade the fishery. Damaged native vegetation can then restore itself much better when cattle are fenced out than when streambanks are moderately grazed.

Intermountain studies showed that continuous use and rest-rotation grazing at heavy rates are especially detrimental to streams. Herded rest-rotation grazing of sheep and rest-rotation of cattle at low rates, however, have very little impact on the fisheries habitat. In eastern Oregon, there was no clear difference among grazing systems at moderate stocking rates, including the no-grazing alternative, in reducing sediment in streams. Severe winter stream flows appear to alter stream banks and beds more than moderate livestock use.



A wide, shallow stream in a heavily grazed area (top) narrows as it enters a lightly grazed area (bottom).

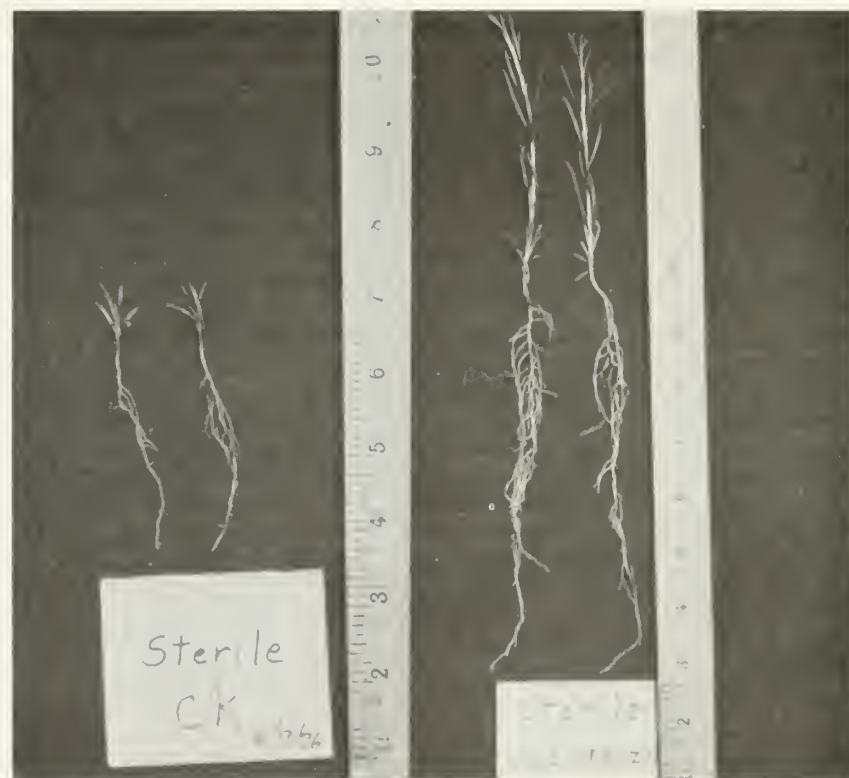
Tiny Organisms Help Speed Revegetation of Surface-Mined Arid Lands

As the Nation moves toward energy self-sufficiency, the huge machines that strip-mine coal deposits move across the dry Southwest. For help in revegetating the mine spoil material left in their wake, scientists at the Rocky Mountain Station are turning to a variety of tiny organisms.

Some kinds of beneficial fungi grow both outside and into plant roots, and form mycorrhizae, a network that helps the roots absorb nutrients and fight off pathogens. For many shrubs and trees transplanted onto mine spoils, inoculation with these beneficial fungi greatly improves survival and growth on these near-sterile, dry, reclaimed lands.

Other research by Station scientists and their university cooperators involves naturally occurring soil insects, especially a small native termite. When the scientists added paper or straw to mine spoils as a source of energy for termites in laboratory tests, the termites rapidly changed both physical and chemical properties of the clumpy spoil toward more normal soil.

Both of these findings have greatly improved our ability to reclaim surface-mined lands in the arid Southwest.



Rabbitbrush seedlings on the left were grown in sterile mine spoil material; seedlings on the right were grown in similar material, but inoculated with mycorrhizae.

Small Trees Play Big Role in the Great Basin

Pinyon-juniper woodlands, sometimes called "pygmy forests," are the dominant vegetation on 17 million acres of the Great Basin. Similar woodlands cover millions of acres in Colorado, New Mexico, and Arizona. Long ignored, these woodlands are now generating a surge of renewed interest. Conflicts arise as the small trees invade areas used as rangeland, crowding out grasses, forbs, and shrubs, and as demands and markets increase tree values for fuelwood and pine nuts. Land managers need basic ecological information as a basis for their plans and decisions.

Researchers at the Intermountain Forest and Range Experiment Station are probing the ecological characteristics and productivity potentials of these pinyon-juniper woodlands. Results of the research have provided resource managers, for the first time, with data on growth characteristics of pinyon and juniper trees, and information on biomass production. The research has also provided methods of measuring and sampling the woodlands, preliminary information on the effects of fires, and ways to increase forage production.



Researchers are developing methods to evaluate productivity of the vast pinyon-juniper woodlands of the Great Basin.

Managing Playas for Wildlife

Some 25,000 playas, or wet-weather lakes, dot the southern Great Plains, providing excellent wildlife habitat in intensively farmed areas. In addition to resident wildlife, playas also attract migratory shorebirds, raptors, and large concentrations of wintering waterfowl. Thus they are a resource of international consequence.

Scientists at the Rocky Mountain Station are studying wildlife on the Texas High Plains and their relationships to playa habitats and surrounding land use. The goal is to provide habitat management guidelines for farmers. The research has shown that ring-necked pheasants use playas for nesting and wintering cover, with February concentrations that can exceed 300 birds on a single 40-acre basin. Wintering waterfowl use playa lakes for resting.

Use of playas for collection of irrigation runoff water seems to be a major determinant of their habitat value. Communities of wetland plants such as cattails and bulrushes are attractive as wildlife habitat, but are seldom present in playas that do not receive irrigation runoff. Through careful management of grazing and cropping, and designing irrigation catchment basins in key playas, farmers can improve their wildlife resources considerably, perhaps building the basis for productive lease or fee hunting.



Wet-weather lakes provide excellent habitat for wintering waterfowl in the southern Great Plains.

What Is Good Bird Habitat?

Forest managers must manage forest lands for wildlife as well as for wood products. Little information has been assembled on what determines nongame bird populations in southern forest stands of different types and ages.

Southern Forest Experiment Station scientists have now gathered information on breeding bird populations under different forest conditions. While some bird species, such as cardinals, are found in most habitats, other species have more specific habitat requirements determined by forest stand age and composition. For example, prairie warblers and yellow-breasted chats need young stands, whereas wood thrushes and red-eyed vireos normally inhabit older stands.

Better understanding of the relationships between birds and forest stands will enable forest managers to favor certain nongame bird species by manipulating forest habitat.



Prairie warblers require stands of young trees.



Timber Management

Assessing the Impact of Brush on Timber Growth

Researchers at the Pacific Southwest Station are quantifying the effect of tree spacing and brush competition on growth and development of ponderosa pine and Douglas-fir on a variety of sites in northern California.

In one study on a highly productive site, spacing and brush effects on growth of ponderosa pine were compared on plots where brush was allowed to develop versus plots kept free of brush. Twelve years after planting, diameters of tree stems on brushy plots were only 76 percent of those on brush-free plots. More than one-fourth the growth potential was lost in brush-choked plots, despite the fact that the site was cleared and groomed before planting, and rapid height growth kept tree crowns above the brush.

In another study, 6-year-old Douglas-fir trees growing in an area cleared of brush were paired with trees on an adjacent area growing in the brush. After 28 growing seasons, trees in the brush-free area averaged 19 feet taller than trees in the brushy area. This difference is equivalent to more than 12 years of growth, and represents an increase of over 10,000 board feet per acre at a harvest age of 100 years.

These studies parallel and reinforce findings from other timber types that demonstrate strikingly the impact on growth of neglecting brush control. Results from these and similar studies on other sites will help managers decide on optimum tree densities and brush control strategies for production of wood.



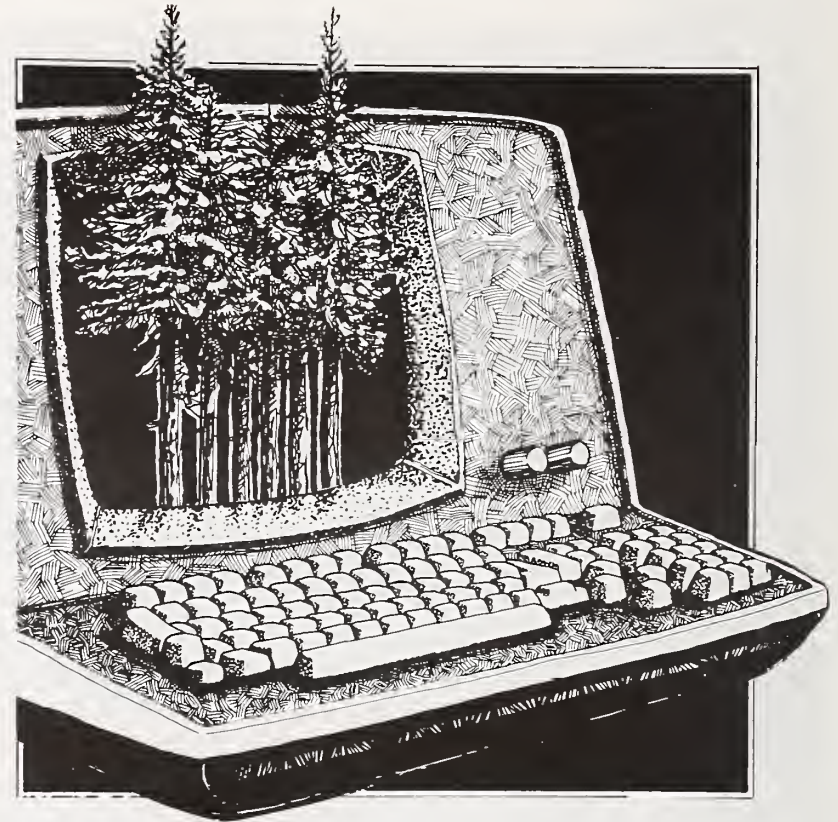
More than one-fourth the growth potential of trees in brush-choked plots may be lost.

Better Douglas-Fir Growth Estimates Mean Better Decisions

A computer simulation program for estimating yields for even-aged managed stands of Douglas-fir has been developed by researchers at the Pacific Northwest Forest and Range Experiment Station and the Weyerhaeuser Company. These yield estimates are based on the largest aggregation of research plot data for coastal Douglas-fir ever assembled. Data were supplied by many Federal, State, and private landowners.

Called DFSIM, the computer program is an important tool for foresters concerned about increasing productivity of Douglas-fir forests. It will generate yield tables for a wide variety of stand conditions and management strategies. These yield estimates assist forest managers in choosing among possible management plans to attain goals. The estimates also provide guides for stand management for various combinations of initial stocking, precommercial and commercial thinning, and fertilization.

Yield estimates prepared by DFSIM are now being used by Federal, State, and forest industry managers in Oregon and Washington to evaluate investment opportunities for increasing forest production. Federal forest managers are also finding DFSIM to be useful for multiple-use forest planning.



The computer is increasing in importance as a tool for foresters.

Even-Aged Management of Ponderosa and Lodgepole Pines in the Rockies

Southwestern and Black Hills ponderosa pine cover types occupy the largest areas of commercial forest land in Arizona, New Mexico, and the Black Hills of South Dakota and Wyoming, respectively. In the central Rocky Mountains, lodgepole pine is the second-largest timber resource in area and volume of commercial forest. These forests yield a variety of timber products, provide habitat for a wide variety of wildlife, forage for livestock, recreational opportunities, scenic beauty, and are important for quality and quantity of water yield. Land managers must direct their efforts toward multiple use practices based on sound silvicultural principles. They must understand the trade-offs between the timber resource and other physical, social, and economic considerations.

Computer program RMYLD, a stand growth and yield model, has been used to predict the potential production of these forest types for various combinations of stand density, site quality, rotation ages, and thinning schedules. Such estimates are needed to project future development of stands managed in different ways for various uses.

The silviculture of these forest types, estimates of growth and yield under even-aged management, and trade-offs to increase values of other resources are discussed in three Research Papers, "Management of Ponderosa Pine in Even-Aged Stands in the Southwest" (RM-225), "Management of Ponderosa Pine in Even-Aged Stands in the Black Hills" (RM-228), and "Management of Lodgepole Pine in Even-Aged Stands in the Central Rocky Mountains" (RM-229).



Ponderosa pine is a major commercial timber species in the Rockies and the Black Hills.

New Pollen Management Techniques Improve Pine Breeding

Genetic improvement of trees is one of the most promising ways to increase pine timber production, but it is a lot easier said than done. The current procedures for taking pollen from superior pines and then applying it to the bagged female flowers on other pines to produce superior trees are complex, time consuming, and expensive. Tree breeders need to get a maximum number of improved seeds for a given amount of effort.

Researchers at the Southeastern Station have now developed new techniques that can double to quadruple seed yields from pollinated flowers. Since pollen often must be stored for a year or more so that it can be applied when female flowers are most receptive, station scientists have developed improved storage methods. To ensure that only viable pollen is used, they have developed reliable techniques for testing its viability after storage. They also have developed a special pollinator that uniformly distributes the pollen grains around the bagged female flowers to conserve pollen and obtain higher seed set. Finally, they have found a way to test large numbers of ovules quickly to see how successful pollination has been in order to evaluate their procedures. These new techniques are already being applied by tree breeders and scientists throughout the country.



The cyclone pollinator distributes pollen grains uniformly around bagged female flowers.

Rust-Resistant Sugar Pine: Finding the Right Genes

Sugar pine, historically one of California's most valuable timber trees, is so threatened by blister rust that the disease has almost eliminated hopes of growing sugar pine in some areas, such as northern California.

Although some sugar pines have been discovered that are resistant to blister rust, the gene that imparts this resistance is so rare in some areas in California that it is almost impossible to find enough selected trees to breed a disease-resistant strain.

Geneticists at the Pacific Southwest Experiment Station have developed a new technique for locating disease-resistant seedlings at an early stage — within months of seed germination. This technique makes it possible to screen large numbers of seedlings to locate those trees that not only carry the rust-resistant gene, but have good form and grow rapidly as well.

Intercrossing in seed orchards established with these seedlings will yield trees that have at least three-quarters the total resistance, are superior in growth to wild trees, and still maintain the diversity of the original population.

This new technique for early identification of rust-resistant seedlings may help reestablish sugar pine as a premier soft pine in West Coast forests.



Technician inspects sugar pine seedlings in greenhouse at the Pacific Southwest Station's Institute of Forest Genetics.

Management of Yellow-Poplar Summarized

Yellow-poplar has been increasing in numbers and volume faster than any other hardwood species in the Southeast, and no one is disappointed. Its tall, straight trunk clean of lateral branches, rapid growth, response to management, freedom from pests and diseases, and useful wood make it a favorite of foresters. Its unique, tulip-shaped leaves, and its beautiful flowers make it a favorite of tourists. Researchers at the Southeastern Station have just completed a handbook summarizing management and use of this valuable and growing resource. They see yellow-poplar as the tree of the future, especially in the southern Appalachians.

The species grows best in moist coves and lower slopes in the mountains, where relatively easy access makes forest management practical. It responds well to stand management. Furthermore, a harvested stand is easy to reproduce. Yellow-poplar produces large seed crops every year, and at the age and size that it is currently being harvested, its stumps sprout vigorously.

At present, yellow-poplar is not fully utilized — growth exceeds cut by a wide margin. As supplies of southern pine become tight, large amounts of yellow-poplar construction lumber and plywood could be produced, greatly expanding forest industry in the southern Appalachians.



Yellow-poplar is easy to reproduce, grows rapidly, and produces useful wood in the southern Appalachians.

Modeling the Impact of Fusiform Rust on Slash Pine

Forest managers can now predict the impact of fusiform rust on future yields of unthinned slash pine plantations. This information is essential for cost-effective management of infected slash pine plantations. It allows managers to evaluate the cost and potential benefits of alternative rust management methods, including use of genetically resistant planting stock.

Researchers in genetics, growth and yield, pathology, and silviculture at the Southern Forest Experiment Station combined their efforts to analyze data representing over 20 years of observations in infected slash pine plantations throughout Mississippi and Louisiana. More than 100,000 individual tree measurements were used to develop survival models that can be integrated into existing growth and yield models for unthinned slash pine plantations.

This attainment illustrates the potential benefits to be gained when research specialists pool data and technical expertise to solve major problems facing forest managers. It also points out the value of long-term research studies in supplying the kind of information required to address such problems.



Fusiform rust is a serious problem on slash and loblolly pines.

More Deer Mean Less Timber

Some of the world's most prized timber grows in the cherry-maple and oak forests of Pennsylvania. These hardwood forests have provided hunters with large annual deer harvests and all the attendant recreational and economic benefits. But the large deer herds, traditional in the State for 40 to 50 years, have created problems as well as enjoyment and income.

Researchers at the Northeastern Forest Experiment Station have recently summarized information on the impact of excessive deer populations on forest vegetation in Pennsylvania. In some areas, deer browsing has prevented the reestablishment of forest trees after harvest. In other areas, deer have altered species composition, reduced vegetation density and growth, limited the kinds of forest management that can be practiced, and reduced the amount of favorable habitat for other wildlife species. The projected loss of timber production alone from excessive deer browsing may average \$1,000 for every acre regenerated, or nearly 50 percent of the potential stand value. This represents a loss of over \$13 per acre per year to the landowners over a browsed area of about 16 million acres.

Scientists believe that the long-term solution to this resource management problem is to bring the deer herd into better balance with its habitat.



Deer browsing has practically eliminated tree reestablishment to the left of the fence.



Fire and Atmospheric Sciences

Fire R_x Dispensed from the Air

In the forester's tool kit for southern pine management, nothing is more effective or valuable than a carefully executed prescribed fire. At the right time and place, a prescribed burn can eliminate dangerous accumulations of litter and brush fuels that would cause an intensive fire, if it started accidentally on a dry, windy day. A prescribed burn can also prepare an area for pine seeding or planting at a very low cost, and it can free pines from the competition of undesirable hardwoods.

The appropriate conditions for a safe and beneficial fire occur only occasionally, however, and foresters need ways to ignite large acreages quickly when conditions are just right. Scientists at the Forest Service's Fire Laboratory in Macon, Georgia, therefore, are evaluating methods for starting fires from the air. Research studies and operational tests indicate that fire can be safely applied 10 times as fast from the air as from the ground, and several large timber companies and two state forestry agencies are already using aerial application.

Two dispensing methods have been tested—"the flying drip torch" and "the ping-pong ball dispenser." In the drip-torch method, a drum suspended below a helicopter dispenses jellied fuel in globs which are ignited just before they drop. In the other method, small spherical plastic containers filled with potassium permanganate are injected with ethylene glycol immediately before they are dispensed. The two chemicals react and begin to burn as the containers fall to the ground. The combined chemicals burn intensely for about 2 minutes—sufficient time to ignite ground fuels.

Research is now concentrating on development of specific guides that will minimize risks to aircraft, and people and property on the ground.



The "ping pong ball dispenser" mounted on a North Carolina Forest Service helicopter.

How Much Fire is Enough? Study Fire-Scarred Trees!

Fire isn't always bad! In fact, when fire burns under prescribed conditions of fuel, weather, and topography, several resources can benefit. The composition of many of our forests today, especially in the West, was shaped to a considerable extent by fires long ago — before people decided to put out forest fires quickly.

Now, with a resurgence of interest in using fire as a forest management tool, we need to know more about the frequency, extent, and intensity of fires that normally burned through various forest types. A unique tool for studying fire history is dendrochronology. The basic idea is not new, except that now annual rings in fire-scarred old trees and stumps can be carefully dated by comparison with known tree-ring patterns and weather records at the Laboratory of Tree-Ring Research at the University of Arizona. Rocky Mountain Station scientists have determined, for instance, that fires burned through a typical mixed-conifer forest in the White Mountains of Arizona at an interval of roughly five per century during the period 1700—1900. An average fire interval of only 2 to 4 years was common in the drier southwestern ponderosa pine. During a 122-year period, 1754—1876, fifty fires burned on a fire-scar study area.

Foresters can use such fire-frequency information when they plan how to incorporate prescribed fire in their management activities. A workshop was held in October 1980 to summarize available knowledge on how to gather, interpret, and use fire history information. Proceedings are available as General Technical Report RM-81 from the Rocky Mountain Station.



Thirty-one fire scars are identifiable between the years 1540 and 1876 on this ponderosa pine that grew near Flagstaff, Arizona.

Fire As a Forest Management Tool

Research conducted by a team of interdisciplinary scientists at the Inter-mountain Forest and Range Experiment Station shows that fire can be used as a precision forest-management tool. The researchers have developed criteria for prescribed fires in logging slash, so that burning can be scheduled to best meet site preparation, hazard reduction, and other management goals. User-orientated computer systems can quickly and easily analyze climatological data to predict desirable conditions for prescribed fires.

The criteria are the results of cooperative studies begun more than a decade ago on National Forests in Montana. During the research, smoke columns and air quality were monitored as well as fire intensity, fire effectiveness, and fuel consumption. During the post-fire years, scientists evaluated plant succession, seed dispersal, seedling survival, growth of new trees, presence of small mammals, erosion, and soil characteristics.

Final results and recommendations are included in "Clearcutting and Fire in the Larch-fir Forests of Western Montana—A Summary of Effects on Several Resources," General Technical Report INT-99. The report contains detailed site, stand, habitat, and treatment descriptions so that forest managers can determine where the prescriptions can be applied.



Western larch seedling developing in the protection of a charred log 6 years after a broadcast burn.

Fuel Appraisal Process Evaluates Fuel Treatment Needs

Timber harvesting, forest stand thinning, and other management activities generate woody residues that increase an area's wildfire hazard. This increased hazard, a threat to investments in forest resources, can be reduced by treating man-caused fuel accumulations to reduce their flammability. The treatments are often expensive, however, ranging from \$1 per acre for some types of prescribed burning to \$1,000 per acre for physically removing unusable residues. Whether these fuels should be treated, and the level of treatment that is necessary, depend on the fire hazard with and without treatment, the effects of fire on resource production, and the values of the resources being managed.

To help managers evaluate fire hazard, scientists at the Rocky Mountain Forest and Range Experiment Station have developed a national fuel appraisal process. The process assesses fire hazard in terms of the area that can be expected to burn, on the average, by wildfires if no fuels are treated or if treatments are applied. Managers can use this information, together with their knowledge of acceptable levels of fire activity, to select a level of fuel treatment that matches costs and resource production goals.

Much of the fuel appraisal process is computerized. A package of four computer programs has been installed at the USDA Fort Collins Computer Center to provide users with the required computer support. To facilitate implementation of the fuel appraisal process and the computer programs, a series of slide-tape instructional courses has been developed and made available through the National Audiovisual Center.



Managers must be able to select a level of fuel treatment that balances costs against resource production goals.

Protecting Homes from Wildfire

Each year wildfires burn hundreds of homes in forest-, brush-, and rangeland. Yet most of these losses could be prevented by following procedures summarized in a report published by the Pacific Southwest Forest and Range Experiment Station.

Procedures for reducing losses include constructing buildings (especially roofs) with nonflammable materials; avoiding balconies and other overhangs; landscaping with vegetation having low fuel volumes; providing adequate access routes, perimeter protection, and water supplies for housing developments; managing wildland fuels to reduce hazard and to facilitate fire control; and adjusting insurance rates, mortgage interest rates, taxes, and other conditions for real estate transactions to reflect actual risks and to encourage fire-safe location, design, and construction.

The report is available as General Technical Report PSW-50, "Protecting Residences from Wildfires: a guide for homeowners, lawmakers, and planners."



Many homes lost to wildfires could have been saved by following protective procedures.

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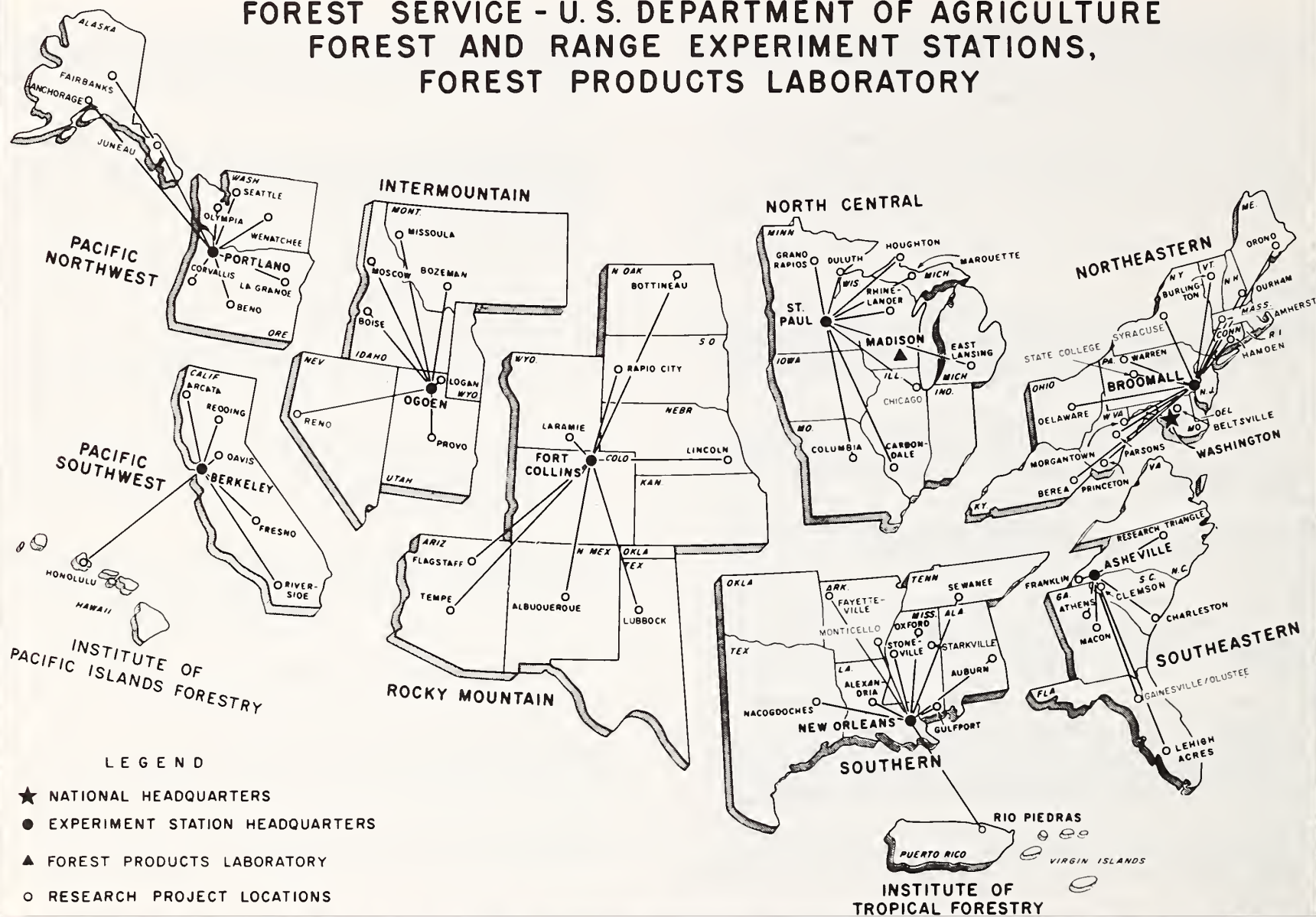
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